



IN THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A color image processing method comprising the steps of:
edge-detection of a digital color original image obtained by digitally inputting only a single side of a document color-printed on both sides of paper;
estimating background color of said paper or background color image on said single side based upon edge-detection information from the single side of the document with respect to a portion with low intensity of said detected edge from the single side of the document;
performing color threshold processing in which said portion with the low edge intensity as a component corresponding to show-through of an image from an opposite side of the document is replaced with said estimated background color or background color image in said original image; and
generating a show-through removed image as an image from which the component corresponding to the show-through has been removed from the original image without using the image from the opposite side of the document and without degradation of an image printed on the single side of the document.
2. (Original) The color image processing method according to claim 1, wherein the edge-detection is performed by calculating edge intensity from each component of an image in which the edge is detected and considering a correlation between respective edge intensity of said components.
3. (Original) The color image processing method according to claim 1, wherein the color threshold processing including the steps of:

binarizing the edge intensity;

in edge distribution in which a pixel with the edge intensity higher than a threshold is obtained as an ON pixel and a pixel with the edge intensity lower than the threshold is obtained as an OFF pixel,

setting a window of a predetermined size in a region of said OFF pixels;

classifying the pixels within each window into two colors;

estimating a color with higher brightness of said two colors as a background color;

replacing the color of the pixels within each of said windows with said estimated background color; and

replacing said original image with said background color image.

4. (Original) The color image processing method according to claim 3, wherein the color threshold processing further including the steps of:

forming a run in each line in a horizontal (or vertical) direction with respect to the region of said OFF pixels;

estimating said background color or background color image using the horizontal (or vertical) runs;

forming a run in each line in a vertical (or horizontal) direction with respect to said estimated background color or background color image in the horizontal (or vertical) direction;

estimating a background color or a background color image using the vertical (or horizontal) runs;

replacing the pixels of said original image corresponding to said OFF pixels with

pixels of said estimated background color or background color image in the vertical (or horizontal) direction; and

replacing said original image with said background color or background color image.

5. (Original) The color image processing method according to claim 3, wherein thresholds in binarization of the edge intensity are automatically set by statistically analyzing distribution of the edge intensity.

6. (Original) The color image processing method according to claim 3, wherein thresholds in binarization of the edge intensity can be set by a user according to a degree of show-through or paper quality.

7. (Original) The color image processing method according to claim 1 further comprising the steps of:

detecting an edge of said show-through removed image;

comparing the edge of said detected show-through removed image to the edge distribution of said original image;

applying again the processing for color threshold processing to the periphery of an edge not existing in said original image, in said show-through removed image; and

generating a corrected show-through removed image.

8. (Original) The color image processing method according to claim 7, wherein, in comparison between the edge of said show-through removed image and the edge distribution of said original image, edge intensity calculated in said original image is subtracted from edge intensity calculated in said show-through removed image at each pixel, and any value higher than a predetermined threshold is determined, in said show-through removed image, as

an edge not existing in said original image.

9. (Original) The color image processing method according to claim 7 further comprising the step of:

setting the size of said window smaller than that in the previous processing when said corrected show-through removed image is generated.

10. (Original) The color image processing method according to claim 1 further comprising the step of:

generating a reduced original image with low resolution from said original image;
generating said show-through removed image with respect to said reduced original image;

calculating a difference between said show-through removed image and said reduced original image to estimate a show-through region; and

allocating pixels of said show-through removed image, that correspond to said estimated show-through region, onto said original image with the original resolution.

11. (Original) The color image processing method according to claim 1 further comprising the step of:

transforming the color coordinate system of said original image or said reduced original image to another color coordinate system such as a YCbCr coordinate system or a pseudo KL color coordinate system, in which the components are highly independent from one another;

detecting said edge; and

performing transformation reverse to said transformation on said show-through

removed image or said corrected show-through removed image.

12. (Currently Amended) A color image processing apparatus comprising:

an edge detection unit which detects an edge in a digital color original image obtained by digitally inputting only a single side of a document color-printed on both sides of paper;

a background color estimation unit which estimates a background color of said paper or a background color image on said single side based upon edge-detection information from the single side of the document with respect to a low intensity portion of said detected edge from the single side of the document; and

an image replacement unit which replaces the low portion of the edge intensity as a component corresponding to show-through of an image from an opposite side of the document with said estimated background color or background color image in said original image,

wherein said image replacement unit removes said component corresponding to the show-through from the original image and generates said show-through removed image without using the image from the opposite side of the document and without degradation of an image printed on the single side of the document.

13. (Original) The color image processing apparatus according to claim 12, wherein said edge detection unit calculates edge intensity from each component of an image in which the edge is detected, and detects the edge considering a correlation between the respective edge intensity of said components.

14. (Original) The color image processing apparatus according to claim 12, wherein said edge detection unit comprises a binarization unit which binarizes the edge intensity, said

background color estimation unit comprises:

in edge distribution in which a pixel with the edge intensity higher than a threshold is obtained as an ON pixel and a pixel with the edge intensity lower than the threshold is obtained as an OFF pixel,

a window setting unit which sets a window of a predetermined size in a region of said OFF pixels;

a color clustering unit which classifies the pixels within each of said windows set by said window setting unit into two colors; and

an estimation unit which estimates a color with higher brightness of said two colors as a background color, and

said image replacement unit comprises a pixel replacement unit which replaces the color of the pixels within each of said windows with said estimated background color.

15. (Original) The color image processing apparatus according to claim 14 further comprising:

a horizontal run formation unit which forms a run in each line in the horizontal direction in the region of said OFF pixels; and

a vertical run formation unit which forms a run in each line in the vertical direction,

wherein said background color estimation unit estimates said background color or background color image using the horizontal (or vertical) runs formed by said horizontal run formation unit (or vertical run formation unit), further estimates a background color or a background color image using the vertical (horizontal) runs formed by said vertical run formation unit (or horizontal run formation unit) with respect to said estimated background

color or background color image in the horizontal (or vertical) direction, and

said pixel replacement unit replaces the pixels of said original image corresponding to said OFF pixels with pixels of said estimated background color or background color image in the vertical (or horizontal) direction.

16. (Original) The color image processing apparatus according to claim 14, wherein said binarization unit has an automatic threshold setting unit which statistically analyzes the distribution of the edge intensity and automatically sets the threshold.

17. (Original) The color image processing apparatus according to claim 14, wherein said binarization unit has a threshold setting unit by which a user sets the threshold according to a degree of show-through or paper quality.

18. (Original) The color image processing apparatus according to claim 12 further comprising:

an edge determination unit which detects an edge of said show-through removed image by said edge detection unit, compares said detected edge of the show-through removed image and the edge distribution of said original image, and determines an edge not existing on said original image; and

a repetition unit which generates again a show-through removed image about the periphery of the edge not existing said original image in said show-through removed image.

19. (Original) The color image processing apparatus according to claim 18, wherein said edge determination unit subtracts edge intensity calculated in said original image from edge intensity calculated in said show-through removed image at each pixel, and determines any value higher than a predetermined threshold, in said show-through removed image, as an

edge not existing in said original image.

20. (Original) The color image processing apparatus according to claim 18, wherein said repetition unit sets the size of said window to a smaller value than that in the previous processing when a show-through removed image is again generated.

21. (Original) The color image processing apparatus according to claim 12 further comprising:

an image reduction unit which generates a reduced original image with low resolution from said original image;

a show-through region estimation unit which calculates a difference between a show-through removed image generated with respect to said reduced original image and said reduced original image to estimate a show-through region; and

a pixel allocation unit which allocates pixels of said show-through removed image, that correspond to said estimated show-through region, onto said original image with the original resolution.

22. (Original) The color image processing apparatus according to claim 12 further comprising:

a coordinate system transformation unit which transforms the color coordinate system of said original image or said reduced original image to another color coordinate system such as a YCbCr coordinate system or a pseudo KL color coordinate system, in which the components are highly independent from one another; and

a coordinate system reverse transformation unit which performs transformation reverse to said transformation on the show-through removed image with respect to the image

transformed by said coordinate system transformation unit.

23. (Currently Amended) A color image processing apparatus comprising:

an edge detection means for detecting an edge in a digital color original image obtained by digitally inputting only a single side of a document color-printed on both sides of paper;

a background color estimation means for estimating a background color of said paper or a background color image on said single side based upon edge-detection information from the single side of the document with respect to a low-intensity portion of said detected edge from the single side of the document; and

an image replacement means for replacing the low portion of the edge intensity as a component corresponding to show-through of an image from an opposite side of the document with said estimated background color or background color image in said original image,

wherein said image replacement means removes said component corresponding to the show-through from the original image and generates said show-through removed image without using the image from the opposite side of the document and without degradation of an image printed on the single side of the document.

24. (Original) The color image processing apparatus according to claim 23 wherein said edge detection means calculates edge intensity from each component of an image in which the edge is detected, and detects the edge considering a correlation between the respective edge intensity of said components.

25. (Original) The color image processing apparatus according to claim 23 wherein

said edge detection means comprises a binarization means for binarizing the edge intensity,
said background color estimation means comprises:

in edge distribution in which a pixel with the edge intensity higher than a threshold is
obtained as an ON pixel and a pixel with the edge intensity lower than the threshold is
obtained as an OFF pixel,

a window setting means for setting a window of a predetermined size in a region of
said OFF pixels;

a color clustering means for classifying the pixels within each of said windows set by
said window setting means into two colors; and

an estimation means for estimating a color with higher brightness of said two colors
as a background color, and

said image replacement means comprises a pixel replacement means for replacing the
color of the pixels within each of said windows with said estimated background color.

26. (Original) The color image processing apparatus according to claim 25 further
comprising:

a horizontal run formation means for forming a run in each line in the horizontal
direction in the region of said OFF pixels; and

a vertical run formation means for forming a run in each line in the vertical direction,
wherein said background color estimation means estimates said background color or
background color image using the horizontal (or vertical) runs formed by said horizontal run
formation means (or vertical run formation means), further estimates a background color or a
background color image using the vertical (horizontal) runs formed by said vertical run

formation means (or horizontal run formation means) with respect to said estimated background color or background color image in the horizontal (or vertical) direction, and

said pixel replacement means replaces the pixels of said original image corresponding to said OFF pixels with pixels of said estimated background color or background color image in the vertical (or horizontal) direction.

27. (Original) The color image processing apparatus according to claim 25, wherein said binarization means has an automatic threshold setting means which statistically analyzes the distribution of the edge intensity and automatically sets the threshold.

28. (Original) The color image processing apparatus according to claim 25, wherein said binarization means has a threshold setting means by which a user sets the threshold according to a degree of show-through or paper quality.

29. (Original) The color image processing apparatus according to claim 23 further comprising:

an edge determination means for detecting an edge of said show-through removed image by said edge detection means, compares said detected edge of the show-through removed image and the edge distribution of said original image, and determines an edge not existing on said original image; and

a repetition means for generating again a show-through removed image about the periphery of the edge not existing said original image in said show-through removed image.

30. (Original) The color image processing apparatus according to claim 29, wherein said edge determination means subtracts edge intensity calculated in said original image from edge intensity calculated in said show-through removed image at each pixel, and determines

any value higher than a predetermined threshold, in said show-through removed image, as an edge not existing in said original image.

31. (Original) The color image processing apparatus according to claim 29 wherein said repetition means sets the size of said window to a smaller value than that in the previous processing when a show-through removed image is again generated.

32. (Original) The color image processing apparatus according to claim 23 further comprising:

an image reduction means for generating a reduced original image with low resolution from said original image;

a show-through region estimation means for calculating a difference between a show-through removed image generated with respect to said reduced original image and said reduced original image to estimate a show-through region; and

a pixel allocation means for allocating pixels of said show-through removed image, that correspond to said estimated show-through region, onto said original image with the original resolution.

33. (Original) The color image processing apparatus according to claim 23 further comprising:

a coordinate system transformation means for transforming the color coordinate system of said original image or said reduced original image to another color coordinate system such as a YCbCr coordinate system or a pseudo KL color coordinate system, in which the components are highly independent from one another; and

a coordinate system reverse transformation means for performing transformation

reverse to said transformation on the show-through removed image with respect to the image transformed by said coordinate system transformation means.

34. (Currently Amended) A computer-readable recording medium storing a computer program containing instructions which when executed realizes the steps of:

edge-detection of a digital color original image obtained by digitally inputting only a single side of a document color-printed on both sides of paper;

estimating background color of said paper or background color image on said single side based upon edge-detection information from the single side of the document with respect to a portion with low intensity of said detected edge from the single side of the document;

performing color threshold processing in which said portion with the low edge intensity as a component corresponding to show-through of an image from an opposite side of the document is replaced with said estimated background color or background color image in said original image; and

generating a show-through removed image as an image from which the component corresponding to the show-through has been removed from the original image without using the image from the opposite side of the document and without degradation of an image printed on the single side of the document.